

4 Worlds: Coping With Technology Complexity

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Abstract

The purpose of this article is to introduce a model for theorizing contemporary information technologies and systems (technology) from a perspective of complexity. Technology is constitutive of the present ubiquitous complexity, and its complexity requires a matching epistemological inquiry. A model inspired by Karl Popper's three-world ontology expanded with a social domain is proposed with this end in mind. The model is called MIPS after its four ontological aspects – material, intellectual, personal, and social. A review of ontologies deployed in information systems research indicates that the social aspect of MIPS has strong grounding. MIPS approaches technology from the four ontological bases and from different actor perspectives. The article reports on pilot testing MIPS on technologies used in social media.

Keywords

Complexity, technology, ontology, epistemology

Introduction

Any domain of contemporary being is characterized by complexity. Complexity generally refers to a higher degree of differentiation within an entity and a significant multiplication of relationships between the differentiated parts. Complex systems evolve in a non-linear manner and exhibit stochastic rather than deterministic behavior. Technology is part of contemporary complexity and its driving force. (Gill, 2013; Kirshbaum, 2002; Lucas, 2007; Raymond et al., 1997; Weick, 1990).

The advent of the public Internet that quickly expanded globally and wireless communication networks proliferated new digital technologies that spread over all walks of life. In the process, the old alphanumeric, graphical, video and audio technologies turned digital. The social has got impregnated with the technical. A big bang of techno-social universe engendered electronic-everything, including economy, home, government, services, science, education, art, politics, war, and peace. Several techno-social waves erupted in just the last two decades. Organizational and inter-organizational processes became electronic; the smart phone turned into a multi-purpose machine; the Internet (of people) has got complemented with the Internet of Things; a data tsunami keeps escalating via Big Data and other, yet unseen forms; and traditional mass media are facing a newly emerging galaxy of social media.

Technology is developed in response to problems in the social and natural environments. The environmental problem can rest on apparent material facts, such as a lack of food or energy sources. The problem can also result from a creative process that frames something less apparent as a problem, such as performing a known activity in a new way (e.g., telephoning while moving, as with the cell/mobile phone). Physical intricacies and social conditions chart the problem space in either kind of problem. Technology in itself is an intellectual representation of the problems, that is, applied knowledge (Campbell, 1988; Lee & Vitányi, 1997; Wood, 1986). The smart phone is more complex in design and functionality than the cell phone that, in turn, is more complex than the landline phone. Computing requirements associated with

multiple tasks applied to many data types set apart design of the smartphone from the cell phone that is limited to transferring voice and alphanumeric data. The knowledge applied in particular technology varies with the overall state of knowledge, the inventor's ingenuity, and social conditions. The historical metamorphosis of the cell phone from a bulky, heavy apparatus to an elegant, hand-held device demonstrates such a historical evolution of technology.

Technology in operation, its internal workings, constitute the third domain of complexity. The processor and numerous parts of a smartphone interact among themselves and with network environments, thereby creating a dynamic open system. Technologies for storing, mining and modeling structured and unstructured data deluging simultaneously from various sources make the world of Big Data a higher order of complexity than do relational database systems.

Finally, the technology user experiences cognitive complexity when operating the technology. This is a world unto itself that includes mastering the know-how and know-what, recall effort, coping with technical ignorance and/or uncertainty, and managing the locus of control. In the case of an information system user, complexity also involves the informing process. This is about applying personal knowledge to the system's outputs in order to infer information-meaning – a dimension of complexity that is neglected when information is assumed to be a thing (Travica, 2011).

It follows from the discussion so far that complexity is manifest in the problem to be solved, in the intellectual solution to the problem, in technology design and its workings, and in technology user's cognition. Two technology-related actors are implicated in the analysis – the designer and the user. The cited domains of complexity are represented in Figure 1.



Figure 1. Complexity Domains

External (environmental) complexity is correlated positively with technology design that is aiming at resolving the environment-located problems. This follows from the cybernetic law of requisite variety. More complex design correlates in turn with more complex internal workings of technology. The complexity trajectory extends to user's cognition although not necessarily in a linear fashion. The virtue of quality design is in bending downward a complexity curve caused by the environment and intellectual representation of the environmental problem. Therefore, the craft of design (applied knowledge) paves the way to a possibility of coping with observed danger of a self-amplifying loop of complexity, the problem noted by researchers (Gill, 2013).

This introductory discussion frames the following research problem: How can we deal with complexity in technology? The purpose of the following discussion is to propose an epistemological vehicle as a possible response.

Popper's Three Worlds and Technology

Karl Popper's inquiry into the nature of knowledge is useful in discussing complexity of technology. He postulated three "worlds" – the world of physical objects, of personal experience, and of human thought creations (Popper, 1978). As opposed to World 1 that is made of matter (inanimate and animate), World 2 consists of individual mind, perceptions, and emotions. World 3 consists of knowledge (in Popper's parlance, "theories"), arts, and other intellectual creations. These worlds are interrelated. For instance,

intellectual creations (World 3) are instantiated in publications (World 1) and influence individual mind and emotion (World 2). Individuals cognize the physical reality (the World 2 to World 1 relationship) that, reversely, inspires these knowing subjects to formulate problems and create solutions that advance knowledge (World 3). In cognizing World 1, individual mind (World 2) learns from, is shaped by World 3.

Popper's philosophical contribution was World 3 to which he attributed an ontological status equal to those attributed to matter and mind. For Popper, ontos is that which can have causal effects upon other things. For a philosophical monist, ontos is either of these. (Popper cites just "materialist monist" but not the idealist counterpart.) A dualist philosopher adds subjective experience to the world of concrete, causing objects. Popper suggests a pluralist ontology, extended with products of human thought – World 3. Although it is created by individual mind over time, World 3 persists independently and causes reversely individual mind. Popper cites Einstein's special theory of relativity as an example. As it became part of the physics science, it made its students think and extend it to such consequences that even its author could not conceive (e.g., engineering of the nuclear bomb).

All three worlds taken in their interactions open up horizons for understanding technology. Popper was occupied primarily with the creation and validation of scientific knowledge (World 3) rather than technology creation. He did not use the term "technology" but plausibly referred to it by citing World 1 objects (e.g., airports and airplanes). Thus, it stands to reason to make conjectures between technology and the three worlds. Technology in part is an offspring of scientific solutions to problems in the physical world. In other words, as already stated, technology is applied formal knowledge (World 3). Technology is an instrument, whereas science behind it is a modality of cognition. While science is applied in technology, there is a residual in technology resulting from the designer's (inventor's, engineer's) research. This is why technology usually bears an experiential or personal stamp of its inventor (Popper's World 2). A technologist can start from the existing body of knowledge and progress through a unique interplay between subjective experiences and ideas on the path leading to new technology.

If this mapping of technology into the three worlds holds, it can be summarized in the following propositions about technology produced (see Figure 2):

- Technology is an instantiation of human intellect, a product of formal knowledge
- Technology is a projection of personal, experiential knowledge
- Technology product is part of the physical world.

Switching the stance from technologist to technology user, or from technology production to technology-in-use, confirms these propositions. To the user, technology appears first as a material thing with certain functionality. The user learns about technology through personal experience. This personal knowledge is significant and represents a personal appropriation of technology, which may even outweigh designed functionality. A visibility of the human intellect (formal knowledge) present in technology is determined by the user's knowledgeability, including ground zero ignorance. Therefore, the following propositions about technology-in-use can be stated (see Figure 2):

- Technology is a material thing imbued with certain functionality
- Personal experience modifies the user's conception of technology
- The visibility of intellectual side of technology varies with the user's knowledgeability.

The three-world perspective opens up horizons for technology-focused inquiry because technology exhibits three faces. The faces are certain, but their look is not – it is different for different actors. By paying attention to knowledge creation that accompanies technology production, this perspective complements the traditional user focus with the designer side. This opening creates a space for introducing other actors as well. Moreover, by raising the status of personal experience, this perspective enriches the human agency character of the technology user.

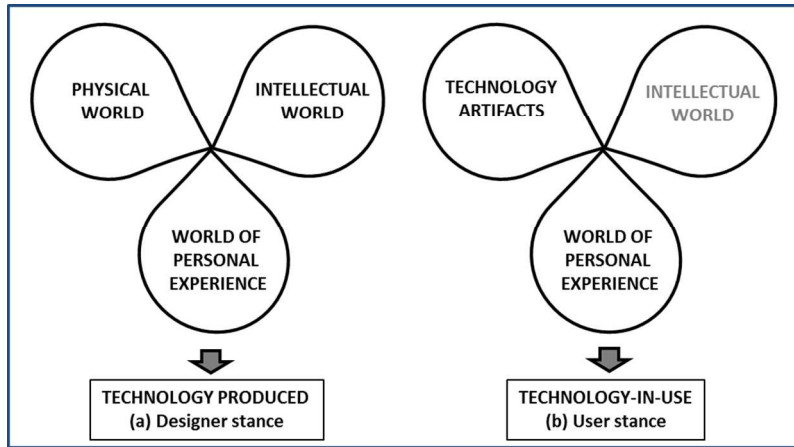


Figure 2. Three Worlds and Technology

The Fourth World

It is interesting that the scope of Popper's theorizing did not engage the social domain. In fact, his placing of culture in World 3 indicates that he did not accredit the social with the same ontological character as matter and mind: "Mention should also be made of the close relationship between what I call world 3 and what the anthropologists call 'culture'. The two are very nearly the same. Both can be described as the world of the products of the human mind..." (Popper, 1978: 166). Popper then pointed out that he disagreed with anthropologists because they placed culture in World 1. Thus, he again missed the social by reducing anthropology to study of material culture devoid of social institutions. The social is also missing as a creator of World 3. Project teams, a form of social organization, apparently create scientific knowledge. Both group mind and individual mind cause World 3.

It can be argued furthermore that new knowledge is a response to problems in a social world as well as it is so in the physical world. Thus, World 3 is influenced by this social world. The same inference applies to technology inasmuch this new knowledge is built into it. This is particularly true of information technologies that are commonly assumed to be the instrument for solving business and broader social problems. In the process of creating new technologies, the designer draws on both formal knowledge and personal experience (Worlds 3 and 2, respectively). The new technology is a material thing, a human artifact, and as such it belongs to Popper's World 1. However, technology-thing is placed into the social context of a firm or some other social form. Subsequently, this social context significantly determines technology-in-use. This line of reasoning indicates a need to supplement Popper's triad with a social segment – World 4.

Figure 3 depicts a model of four worlds. It is called MIPS after the initials of the worlds' names – Material, Intellectual, Personal, and Social. The model draws on the discussed Popper's work expanded with the fourth social world, and it brings slight lexical adjustments fitting the current discussion. The MIPS model posits that technology exhibits four faces. Consequently, full understanding of it calls for engaging these different views, while moving the anchor to the designer, user, and other actors.



Figure 3. MIPS Model of Four Worlds

The MIPS model accounts for generic ontologies indexed in standard philosophical dictionaries rather than specialist ontologies that emphasize some ontos over others. Such a pluralism is consistent with the integrationist intention behind the model and the complex system perspective. Specialist ontologies tend to be applied in particular research disciplines. The following discussion will show how the MIPS model relates to the specialist ontologies in information systems (IS) research.

Ontology of Information Technologies and MIPS

In research on information systems (IS), the social world advocated by the MIPS model has already been implied and extensively addressed. This World 4 is apparent firsthand in the commonly endorsed concept of information system (IS) that suits the organizational context. An IS is a whole comprised of information technologies (IT), data, and procedures. Procedures apply to the deployed IT (computer software and hardware, and pre-electronic technologies). It is often difficult to separate these procedures from work procedures. The more automated an IS, the more system procedures are indistinguishable from work procedures. The social world (the organization of work) gets embedded in the IS.

World 4 is also visible in impacts that key actors exert in the organizational context. These are manager, technologist, teammate, and peer. Management control shapes IS design (World 1). Technologists responsible for an IS exert the same influences albeit mainly motivated by professional knowledge (World 3). Teammates engender group behavior that shapes the manner in which group support systems get adopted and used. Peers in dyadic settings may act in the same direction. These effects amount to modifying the appearance of technology-thing to socially constructed technology-in-use.

The social domain giving rise to World 4 is further manifested in organizational forces. One can view these in terms of structures of domination, legitimation and signification (Giddens, 1979, 1984). Or in a more IS-focused parlance, World 4 surfaces via infopolitics, infoculture, infostructure, and infoprocesses (Travica, 2003, 2014). Each of these dimensions is an intersection between the underlying organizational realm and technological and cognitive artifacts. For instance, managers' budget manipulation intentions play out in a systematic manipulation of financial reports that, in turn, constitutes a modality of power called meaning management. Or, an IS can be shaped to sustain values of individual competition/cooperation, efficiency, and so on. In a word, social order makes part of IS not less than technical properties. System functionality embodies social order.

Researchers in the IS field have coped with complexity of technology. From the philosophical perspective, this effort has surfaced in various ontologies of technology (Travica, 2014). World 4 plays a prominent role in the ontologies, beside World 1. This is obvious in *socio-technical* inquiry that has had a massive following (e.g., Bostrom & Heinen, 1977; Kling, 1997/2007; Mumford & Weir, 1979). This approach has focused on technology-thing and technology-in-use as socially shaped. Socio-technical ontology has been deployed liberally method-wise and often without explicit claims. Some theories bear a stamp of this approach, in spite of the authors' initial aspirations (e.g., Adaptive Structuration Theory; DeSanctis & Poole, 1994).

World 4 also enjoys a prominence in *structuration ontology* based on Giddens’s (1979, 1984) theory that has had some following in IS research (Orlikowski, 1992; Orlikowski & Yates, 1994). However, structuration theory conceives the social in terms of structures that are brought into a dialectical relationship with action. Structure enables and channels action, while action materializes and possibly changes structure. One does not exist without the other. Structuration ontology addresses both the technology creation and use. The actor aspect refers to Popper’s World 2: the personal experience of a designer shapes technology’s functionality, while a user’s experience shapes technology-in-use. The social *ontos* (World 4) is also implicated in the sociomaterial approach (Orlikowski, 2007). Technology is that which materializes in social practice. As the latter is assumed to have material character, this approach also qualifies as a “new materialism” (cf. Lennon, 2014; more remarks below).

The actor focus (World 2) is exclusive in *action* or *strategic choice* ontology (e.g., Zuboff, 1988). Users inevitably convert technology-given into technology-in-use. Therefore, technology is not a given but what the users sees. If action drivers are not always visible in instances of this approach, *cognitive ontology* can fill the gap (Travica, 2014: 203-206). This approach can be traced in some case research in the IS field, although its theoretical grounding is to be sought elsewhere (e.g., Gagliardi, 1996; Weick, 1990; Weick et al., 1999). The focus is on the mental models and symbol making/interpretation of technology users. Apparently, World 2 gets quite magnified as technology obtains a psychological existence. Moreover, World 2 also poses in the symbolic action approach that focuses on communication as action and on meaning construction in groups and communities of IS users (Aakhus et al., 2014). Technology thus appears as the source of linguistic symbols open to individual and group cognizing. Reality is both represented and constructed through symbols-bound action.

Finally, Popper’s World 1 of matter was addressed in the IS field as well. Known under the label *technology imperative view*, *materialistic ontology* puts the emphasis on technology-thing. A given functionality is a determinant of behavior, organization, and performance (e.g., Huber, 1984; Whisler, 1970). Salient endorsing of this initially ruling view gave way to other ontologies cited here and rather a tacit following (e.g., research on the economic value of IS). Proponents of actor-network theory advocate a materialist approach by drawing on sociology of associations (Latour, 1998, 2005; Law, 1996) and assuming that physical technology constitutes agency as much as humans do.

IS Ontology / MIPS	Material (World 1)	Intellectual (World 3)	Personal (World 2)	Social (World 4)
Socio-technical	U			U
Structuration		D	D, U	D, U
Action/Strategic Choice			U	
Cognitive			U	
Symbolic Action			D, U	
Technology imperative	U			
Actor-Network theory	U			U, D
Sociomaterial	U			U, D

Note: U=user focus, D=designer focus

Table 1. Ontologies of Information Systems

The discussion above demonstrated that the MIPS model of four worlds resonates with ontologies deployed in IS research. Table 1 maps these two. It indicates that each ontology contributes to the four-faced view of technology that MIPS advocates. It is also visible that research has leaned toward the user side. The designer stance deserves more attention nowadays when technological solutions across extensive digital environments are made and applied in real time. Premises behind MIPS allow for expanding the designer focus with any of the ontologies. In addition, the mapping in Table 1 reveals a lack of investigating IT/IS as a knowledge product (World 3). Such inquiry would claim more space for critical thinking over the demonstrated preoccupation with the issue of adopting any trendy technology.

Understanding particular technical limitations and potentially disadvantageous social consequences would improve both academic and practical contributions of research.

The mapping in Table 1 also indicates the exclusion of general ontologies within specialist ontologies. For instance, the much used socio-technical approach omits the intellectual and personal aspects (although these may be implied within the social). The sociomaterial approach follows the suit. In addition, it entangles differing conceptualizations of sociomaterial, such as equating the social and material, placing the sociomaterial in the technical segment of socio-technical ontology, and importing the notion of intra-action enacted agential cut from Barad's (2003) physico-feminist philosophy. (Cf. Cecez-Kecmanovic, 2014; Kleinmann, 2012; Lennon, 2014; Leonardi, 2012; Orlikowski, 2007).

The MIPS model advocates that technology is conceived in a multifaceted manner by different actors. It is material but also intellectual, personal but also social. To grasp the MIPS aspects, the inquiry needs to probe each of the aspects as follows:

- *Material*: What functionality and physical shape does technology present to the actor? This question probes on technology-thing in terms of built-in functions; the imposing physical characteristics and affordances also matter.
- *Intellectual*: What intellectual content embedded in technology does stand out for the actor? This question probes on the actor's awareness of formal knowledge technology embodies.
- *Personal*: How does an actor personally experience technology? Sensations, emotions, thoughts, and personal knowledge are all relevant.
- *Social*: Which social actors, forms and roles does technology enable, whether the focal actor is or not aware of?

MIPS is supposed to serve as the means of inquiry, an epistemological vehicle. Agency is still assumed to be human. Human actor is in the focus and the problem addressed is: How does technology come across to the actor subjectively and objectively? The subjective plane implies the actor's engagement with technology, while the objective plane does not. Technology lies at the intersection of these planes. For instance, the social aspect of technology is the social rules shaping it, which the actor comprehends, as well as the institutional content of which the actor is not aware. Put another way, for the focal actor, technology is the product of both the known and unknown actors. For example, for a user of social media technology is the mediator for socializing with peers. Interaction with peers defines what the social medium is for this user. The user may not see, however, the medium's owner that also resides in the social plane. MIPS assumes this switching from the perspective of one actor to another.

The persistence of human agency may elude the observer in the time of pervasive automation. Airplanes fly on the automatic pilot. Cameras register our behavior in public places whether we know it or not. Our Internet searches are continuously catalogued and processed so our next search will be better. Monitoring and remote control devices making the Internet of Things work incessantly and drive automated environments while we sleep. Our digital traces left in cyberspaces are continuously recorded and we are being profiled regardless of our awareness. Internet search systems deliver an ever changing content that shapes the way we think, make decisions, do science... And so on. It seems that humans have got entangled in the world of technology acting on its own. Reality created, or reality that matters, is that which is engendered by technology in a major way.

Although it appears that agency spreads from humans to technology, this is a deception. The unprecedented capabilities of technology result ultimately from volition of social actors rather than possessing volition on its own. Technology mediates power of social actors in the domains of commerce, governance, politics, and technology production. Power mediated produces effects of both domination (over us) and of autonomy to act (toward achieving our purposes with technology). The MIPS model assists in comprehending this dialectics. The given functions of technology-thing (World 1) are extensions of social actors (World 4), embodying human intellect (World 3), which is deployed and slanted by the designer's cognition (World 2), and moderated by the individual or group user (Worlds 2 and 3) into technology-in-use. Agency is still human. Unless machines start self-designing/reproducing and acting on their own, a human persists behind even extremely automated nonhumans. Or as the inspirer of MIPS phrased it commenting on how World 3 theories inspire human mind of World 2 to change World 1:

Human understanding, and thus the human mind, seems to be quite indispensable.
Some people think that computers can do it too, because computers can work out the

logical consequences of a theory. No doubt they can, if we have constructed them and instructed them by way of computer programmes which we have thought out. (Popper, 1978: 164).

The following discussion will apply MIPS to making propositions/hypotheses about social media.

Social Media under MIPS Lenses

Social media are functionally more complex conglomerations of various information systems under the umbrella of Website (Facebook and the likes) or functionally less complex Internet-centric systems (Twitter, blogs, file sharing sites), which support connectivity and communication. Although these media are businesses and are associated with businesses uses, they reside in a broader social context that ranges from the community to global level. As such, social media involve various actors. While users make an actor as with any IS, the social media user is differentiated. For example, end-users of a social medium make a user category that is separate from a marketing company (the third party) using the medium for advertising. Social media also carry out multiple functions and may have impacts on social structuring. Technologies of social media are complex. Understanding them requires a liberal inter-disciplinary approach, including media studies. A good point of departure is comparing social media with classical mass media.

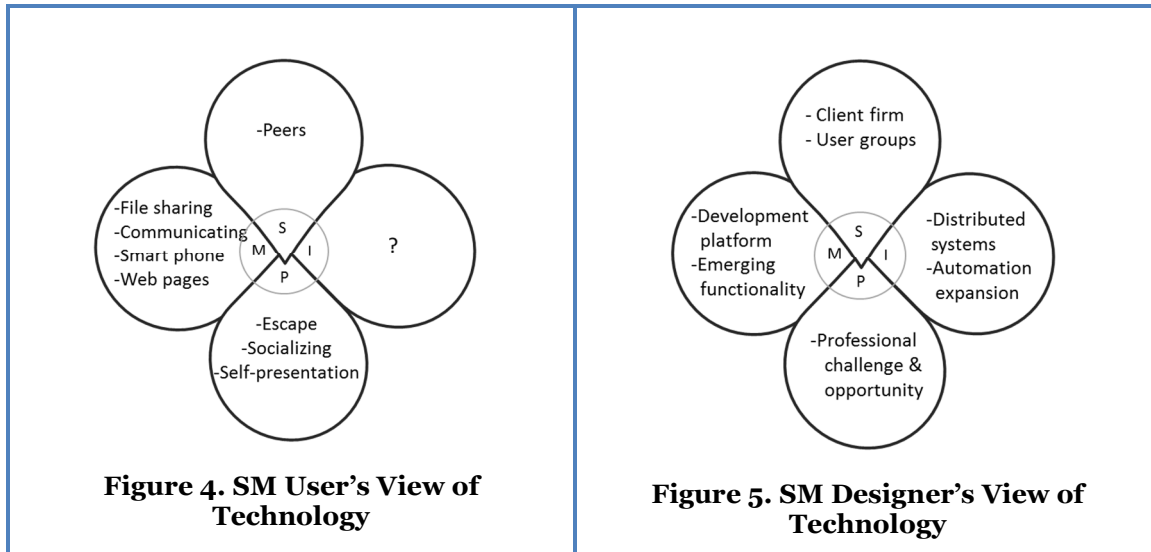
Marshall McLuhan was an early media theorist preoccupied with electronic media that reigned in his time – TV, radio, and film. He argued that these media were bound to cause a major change in human cognition, communication, action and, consequently, social organization. He also considered computer that was still in its infancy, as in arguing that “instead of tending towards a vast Alexandrian library the world has become a computer, an electronic brain” (McLuhan, 1962: 32). The new media were replacing the print medium, which was responsible for the advent of individualism. Embraced by new generations, new media were reversing the direction to a *global tribalism*. In particular, TV was remaking the world into a *global village*. Every news could be made available instantly to the global audience. McLuhan argued that video imagery was creating a space for connotative interpretations based on values and a cognitive makeup shared within subcultures of new generations. The visual media became *extensions of human senses, body, and mind*. By interacting with message senders and receivers in a peculiar manner, the new media actually participated in shaping the messages rather than just being their conduit. In McLuhan’s parlance, *the medium is the message*. (See McLuhan, 1960, 1962, 1964.)

McLuhan’s ideas remain valid and visionary. Any technology is an extension of (limited) individual capabilities. Technology facilitates known activities or enables what has previously been inconceivable. Social media, which were born at the turn of millennia, extend human capabilities in many ways. As people in various walks of life connect via social media for socializing, entertainment, commerce, political cause and other reasons, they extend old social spaces and create new ones. Social media continue the historical trajectory initiated by Internet-based gaming, computer-mediated communication (Internet relayed Chat, email distribution lists), electronic forums, and forms of virtual organizing (virtual community, virtual organization, etc.). All these Internet-native entities do extend human capabilities.

Social media in particular may be seen as extenders of the senses in McLuhan’s sense of the term. They carry visual imagery that is open to interpretations of the involved insiders. A new capability stems from combining imagery in the hypertext fashion. A stochastic character of hypertext linking across expanding digital spaces constituting the World Wide Web elevates extensions of senses to a historically unprecedented level. The global village has expanded and solidified. Present history has confirmed McLuhan’s boldest ideas. However, there are differences between mass media and social media.

The fundamental communication channel is different – the Internet. The channel shift has engendered specific differences. While the mass media were (and are) controlled by circles of economic, political and technocratic power, the Internet is less susceptible to concentrated control. Rather, it is the domain of competing powers, one of which is *vox populi*. The voice and action of people reverses structuring of global village from top-down to ground-up. Applying MIPS gives rise to hypothesizing that each of the actor groups in the social media-based global village may see a particular medium from four angles. These can be probed by asking the MIPS questions cited in the previous section.

To many actors, a social medium appears first as material digital technology (World 1 of matter, the M-area in the MIPS model). This question probes on technology-thing in terms of built-in functions and imposing physical characteristics and affordances. Different actors may see different aspects of this materiality. The *user* is likely to see given functionality of the medium in the foreground, some frequented Web pages, and the “app” running on his smart phone and affording very little beyond a colorful icon (Figure 4). In contrast, the *designer* may see the social medium as a development platform with evolving functionality carried out by a conglomerate of the involved information systems and telecommunications networks (Figure 5).



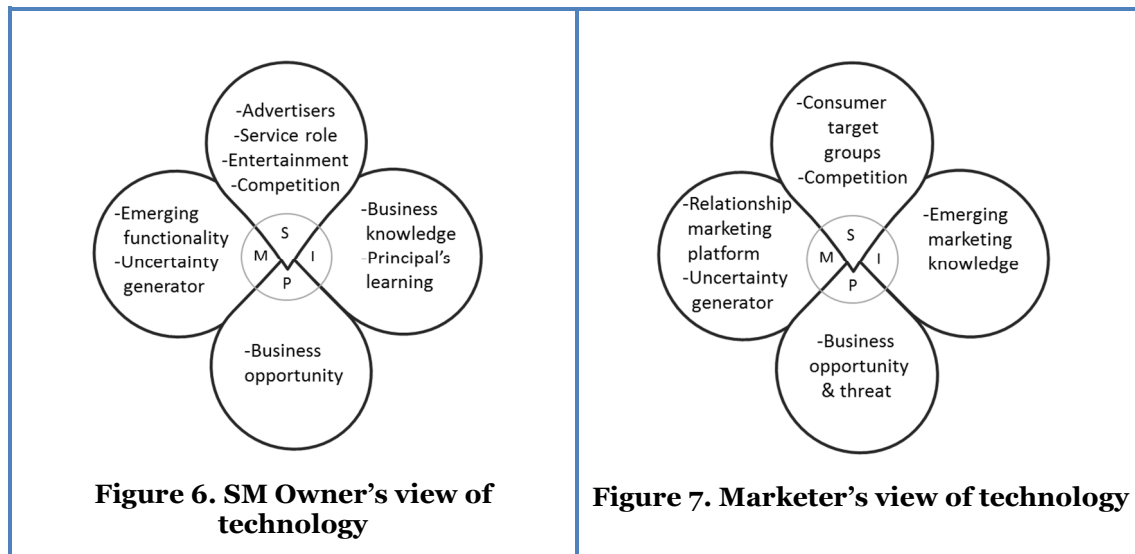
M=material, I=Intellectual, P=personal experience, S=social; SM=Social medium

The *designer* can conceive of substantial knowledge of distributed systems, which is deployed in building a social medium. Technology also extends the realm of automation (the I-area in Figure 5). Think of users that access a social medium via smart phones to discuss housing. The key words from the discussion can trigger a map that locates real estate listings that conjure up a street view that triggers GPS that enables routing the users to the listings. Although the users enjoy the service, they may remain unaware of the complex automation enabling it (note the question mark in Figure 4).

The *owner* of a social medium may also grasp knowledge behind the medium, although this is different knowledge pertaining to communication, organization, management, and business (Figure 6). As the owner may miss technical knowledge, the medium also poses as the learning ground for managing the *designer* (the principal-agent problem). Similarly, a *marketer* that advertises on the social medium may associate technology with emerging marketing knowledge (Figure 7).

How does an actor personally experience social media through sensations, emotions, thoughts, and personal knowledge? This is the P-area in the MIPS model. While for the *user* a social medium offers escape and a means of self-presentation (Figure 4), for the *owner* this technology is business opportunity and perhaps the means of self-achievement advocated by stories of *nouvelle-riche* (Figure 6).

This contrast in the personal experience complies with the contrast in technology as a social entity. This is the S-area in MIPS pinpointed by the question: What is technology or what it should be with regard to the social parties affecting the focal actor? This question is aiming at the relationship between the focal actor and other relevant actors that the former may or may not be aware of. It is the question of relevant social forms and of social roles played. From the *user's* stance, the relevant social form is peer communities (Figure 4). For the *owner*, a social medium enables a connection with advertisers to be utilized for generating revenues (Figure 6). This is enacted if social media technology is capable of offering certain services to the users and possibly entertainment. Allured by connectivity and services, the *user* may be blind for monetizing dynamics behind social media (van Dijck, 2013).



M=material, I=Intellectual, P=personal experience, S=social; SM=Social medium

For the *marketer*, a social medium establishes a new bridge to consumers, for investigating and targeting them (the S-area in Figure 7). It is a new ground for competition, same as for the owners. Guerilla marketing techniques in which “friends” clandestinely promote brands are again in a stark contrast with the medium’s social role concerning *users*. Furthermore, for both the *marketer* and the *owner* the evolving functionality of social media may frame technology as a generator of uncertainty (refer to Figures 6 and 7). The *marketer* dreams of viral marketing in sequel; the *owner* dreams of breaking new grounds and of wealth. Still, evolving social media bring to bear uncertainty regarding the prospects of their acceptance, competition from other social media, and return on investment. In conclusion, applying MIPS to understanding social media may sketch a rich picture of technologies behind social media.

Conclusion

It has been argued that technology is part of omnipresent complexity. As such, it requires epistemology of requisite variety. A MIPS model inspired by Karl Popper’s pluralist ontology was introduced as a means toward this end. The model expands Popper’s three-world ontology (material, intellectual, personal) with a social realm. MIPS frames technology as four inter-related faces. It also assumes that technology should be looked upon from the perspectives of different actors. The look of each technology face can be different for different actors. MIPS-based inquiry was demonstrated on the example of social media. Propositional/hypothetical in character, the discussion illustrated broader possibilities for researching complex technologies.

The MIPS model intends to afford a 4-base playground for the known general ontologies as well as any specialist ontology. As it is inclusionary rather than discriminatory, the model encourages ontological pluralism. One important implication is that technology particulars preclude cookie-cutter ontologizing. For instance, viewing a living body as an evolving assemblage of biological matter and material technology (both within World 1) may be insightful in studying wearables and self-regulated implants that upkeep vital functions in a cow or a human. In contrast, omitting the social and personal aspects of MIPS, or not differentiating between these and material technology could be a recipe for normal accidents (Perrow, 1999/1984), when blueprinting a nuclear plant or an aircraft at flight.

In conclusion, MIPS can contribute to broadening horizons of theorizing information technologies and systems and potentially any technology. Analysis in this article was limited to currently popular social media. What lies ahead is expanding MIPS-driven research to various technologies.

REFERENCES

- Aakhus, M., Ågerfalk, P., Lyytinen, K., Te'eni, D. 2014. "Symbolic Action Research in Information Systems: Introduction to the Special Issue," *MIS Quarterly*, (38:4), pp.1187-1200.
- Barad, K. 2003. "Posthumanist Performativity: Toward an Understanding of How Matter Comes to Matter," *Signs* (28:3), pp. 801-831.
- Bostrom, R., and Heinen, J. 1977. "MIS Problems and Failures: A Socio-Technical Perspective," *MIS Quarterly* (1:3), pp. 17-32.
- Campbell, D.J. 1988. "Task Complexity: A Review and Analysis," *Academy of Management Review* (13:1), pp. 40-52.
- Cecez-Kecmanovic, D., Galliers, R. D., Henfridsson, O., Newell, S. M., Vidgen, R. 2014. "The Sociomateriality of Information Systems: Current Status, Future Directions," *MIS Quarterly*, (38:3), pp. 809-830.
- DeSanctis, G., and Poole, M. S. 1994. "Capturing the Complexity in Advanced Technology Use: Adaptive Structuration Theory," *Organization science* (5:2), pp. 121-147.
- Giddens, A. 1984. *The Constitution of Society: Outline of the Theory of Structuration*. Cambridge, UK: Polity Press.
- Giddens, A. 1979. *Central Problems in Social Theory: Action, Structure and Contradiction in Social Analysis*, London, UK: Macmillan.
- Gill, T. G. 2013. "Complexity, Cybernetics, and Informing Science: Building a Better Mousetrap," *Systemics, Cybernetics, and Informatics* (11:9), pp. 53-68.
- Huber, G. 1984. "The Nature and Design of Post-industrial Organization," *Management Science* (39:8), pp. 28-951.
- Kirshbaum, D. 2002. "Introduction to Complex Systems," Available: <http://www.calresco.org/intro.htm>.
- Kleinmann, A. 2012. "Intra-Actions: Interview with Karen Barad," *Special dOCUMENTA (13) Issue of Mousse Magazine* (34), pp. 76-81.
- Kling, R. 2007/1999. "What is Social informatics and Why Does It Matter?," *The Information Society* (23), pp. 205-220.
- Latour, B. 2005. *Reassembling the Social: An Introduction to Actor Network Theory*, New York, NY: Oxford University Press.
- Latour, B. a.k.a. J. J. 1998. "Mixing Humans and Nonhumans Together: The Sociology of a Door-Closer," *Social Problems* (35:3), pp. 298-310.
- Law, J. 1986. "On Power and Its Tactics: A View From the Sociology of Science," *The Sociological Review* (34:1), pp. 1-38.
- Lee, M. and Vitányi, P. 1997. *An Introduction to Kolmogorov Complexity and Its Applications*, New York, NY: Springer.
- Lennon, K. 2014. "Feminist Perspectives on the Body," *The Stanford Encyclopedia of Philosophy* (Fall 2014 Edition), Available: <http://plato.stanford.edu/archives/fall2014/entries/feminist-body>
- Leonardi, P. M. 2012. "Materiality, Sociomateriality, and Socio-Technical Systems: What Do These Terms Mean? How Are They Related? Do We Need Them?," In P. M. Leonardi, B. A. Nardi, & J. Kallinikos (Eds.), *Materiality and Organizing: Social Interaction in a Technological World* (pp. 25-48), Oxford: Oxford University Press.
- Lucas, C. 2007. "Complexity & Artificial Life - What are they?," Available: <http://www.calresco.org/cal.htm>
- McLuhan, M. (1960). Marshall McLuhan's interview to CBC TV. Available: <http://www.wnyc.org/story/145612-celebrating-marshall-mcluhans-legacy/>
- McLuhan, M. 1962. *The Gutenberg Galaxy: The Making of Typographic Man*, University of Toronto Press. Toronto, ON.
- McLuhan, M. 1964. *Understanding Media: The Extensions of Man*, New York: McGraw Hill.
- Mumford, E., and Weir, M. 1979. *Computer Systems and Work Design: The ETHICS Method*, New York: Wiley & Sons.
- Orlikowski, W. 1992. "The Duality of Technology: Rethinking the Concept of Technology in Organizations," *Organization Science* (3:3), pp. 398-427.
- Orlikowski, W. J. 2007. "Sociomaterial Practices: Exploring Technology at Work. *Organization Studies*, (28:9), pp. 1435-1448.

- Orlikowski, W., and Yates, B. 1994. "Genre Repertoire: The Structuring of Communicative Practices in Organizations," *Administrative Science Quarterly* (39), 541-574.
- Perrow, C. 1999/1984. *Normal Accidents: Living With High Risk Technologies*, Princeton, NJ: Princeton University Press.
- Travica, B. 2003. "Information View of Organizations: Contextualizing Technology—Technologizing Context," *Proceedings of the AMCIS Conference*, August 4-6, 2003, Tampa, FL.
- Travica, B. 2011. "Back to Basics of Informing: The INIS Principle," *Interdisciplinary Journal of Knowledge, Information, and Management* (6), pp. 177-196.
- Travica, B. 2014. *Examining the Informing View of Organization: Applying Theoretical and Managerial Approaches*, Hershey, PA. IGI Global.
- Popper, K. 1978. "Three Worlds. The Tanner Lecture on Human Values," The University of Michigan. Available: <http://tannerlectures.utah.edu/documents/a-to-z/p/popper80.pdf>
- Raymond, E., Horsfall, S., and Lee, M.E. (eds.) 1997. *Chaos, Complexity and Sociology: Myths, Models, and Theories*. Thousand Oaks, CA: Sage Publications.
- van Dijck, J. 2013. *The Culture of Connectivity: A Critical History of Social Media*, Oxford, UK: Oxford University Press.
- Weick, K. 1990. Technology as Equivoque: Sensemaking in New Technologies," In Goodman, P. (ed.), *Technology and Organizations*, San Francisco: Jossey-Bass, pp. 1-44.
- Weick, K., Sutcliffe, K., and Obstfeld, D. 1999. Organizing for High Reliability: Processes of Collective Mindfulness," in Sutton, R, and Staw, B. (eds.), *Research in Organizational Behavior, Volume 1*, Stanford: Jai Press, pp. 81–123.
- Whisler, T. 1970. *The Impact of Computers on Organizations*, New York, NY: Praeger.
- Zuboff, S. 1988. *In the Age of the Smart Machine: The Future of Work and Power*, New York: BasicBooks.
- Wood, R. 1986. "Task Complexity: Definition of the Construct," *Organizational Behavior and Human Decision Processes* (37), pp. 60-82.